as the discoverer of facts which have often thrown unexpected light on the problems of our science, and have always, at least, been of the highest importance, and stated with admirable truth and modesty."

THE *Annales de Chimie et de Physique* reproduces in its August number a paper relating to the theory of dissipation of energy, read by Macquorn Rankine at the British Association meeting in 1852.

A SERIES of scientific ascents were made on Sunday afternoon from the Place Saint Jacques, in Paris, under the auspices of the Académie d'Aérostation Météorologique. At a height of eight hundred feet photographs of the entire horizon were taken by means of a panoramic apparatus invented by M. Triboulet. In a brief explanation of this, given by one of the members of the Academy, it was pointed out that the experiment was as important from a military as from a scientific point of view, since it would enable an army to ascertain exactly the number and position of their enemies. At another ascent telephonic conversation with persons on the ground was carried on at the height of five hundred feet. The experiments were under the auspices of the Municipal Council of Paris.

THE aurora borealis which was seen in so many parts of England on October 2, was also visible in France from a very large number of places.

M. DUVAUX, the French Minister of Public Instruction, has opened the first superior school for females established in France. It is situated in the city of Rouen, and the regular course of study will begin this year. Many similar establishments are in course of construction in several parts of the country.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis* ♀) from East Africa, presented by Capt. F. W. Schwedler; a Binturong (*Arctictis binturong*) from Malacca; a Common Fox (*Canis vulpes* ♀), British, presented by Mrs. Studholme Brownrigg; two Goshawks (*Astur palumbarius*) from Germany, presented by Dr. Rudolph Blasius, C.M.Z.S.; a Common Raven (*Corvus corax*), two Lesser Black-backed Gulls (*Larus fuscus*) from Scotland, presented by Mr. F. G. Bury; two Greater Sulphur-crested Cockatoos (*Cacatua galerita*) from Australia, presented by Mr. C. Kerry Nicholls, F.Z.S.; a Puff Adder (*Vipera arietans*) from South Africa, presented by Lieut. R. Crawshay; an Ornamented Lorikeet (*Trichoglossus ornatus*) from Moluccas, a Crested Curassow (*Crax a'ector*) from Guiana, two Illiger's Macaws (*Ara maracana*) from Brazil, purchased; two Brazilian Hangnests (*Icterus jamaicai*) from Brazil, deposited; an Australian Fruit Bat (*Pteropus poliocephalus*), born in the Gardens.

CHEMICAL NOTES

AN exceedingly ingenious patent for the manufacture of hydrogen and oxygen has been taken out by M. N. A. Hélouis, of Paris. Wood charcoal is obtained by heating wood in closed vessels: the gas which is evolved is used for heating the retorts in which hydrogen and oxygen are produced, the tar is used for carburetting hydrogen, the pyroligneous acid is employed to decompose sodium sulphite (produced in another stage of the process), whereby sulphurous acid and sodium acetate are obtained. By passing steam over hot wood charcoal, a mixture of hydrogen, carbon monoxide, and dioxide is obtained; the mixed gases are passed into retorts containing heated gypsum, which is reduced by carbon monoxide to calcium sulphide; the escaping carbon monoxide is absorbed by soda solution, giving sodium bicarbonate. Oxygen is obtained by decomposing gypsum (600 parts) by silica (340 parts river sand); the mixture of sulphur dioxide and oxygen which is produced, is passed into caustic soda solution, whereby sodium bisulphite is formed; the residual sulphur dioxide is absorbed by milk of lime. The calcium sulphite produced by the final washing of the mixed gases is decomposed by sodium bicarbonate, giving calcium carbonate and sodium bisulphite; the latter is decomposed, as already described, by pyroligneous acid, and the sulphurous acid produced is oxidised to sulphuric acid in a cylinder containing platinised pumice-stone, by air containing 75 per cent. of oxygen. The calcium sulphide which remains in the oxygen retorts is decomposed by carbon dioxide and steam; the sulphuretted hydrogen produced, after being freed from moisture by passing through a condensing apparatus, is burned with air rich in oxygen, and the sulphurous acid formed is conducted into the leaden chambers of the sulphuric acid manufactory. Air containing 75 per cent. oxygen is obtained by pumping air into a cylinder containing a mixture of 80 parts water and 20 parts glycerine; when the pressure has reached 10 atmospheres, communication is made between the first cylinder and another from which air has been removed; air rich in nitrogen remains in the first cylinder. By repeating this operation, a mixture of 75 per cent. oxygen and 25 per cent. nitrogen can be obtained. Another method of obtaining nearly pure oxygen from air consists in passing the latter into an iron cylinder containing a bag of silk covered with caoutchouc; the dialysed air is then driven by a steam jet into a condenser, and thence passes into a second similar cylinder; this process is repeated several times; a mixture of 98 per cent. oxygen and 3 per cent. nitrogen may thus be obtained, but for most metallurgical or lighting purposes a mixture containing 60 per cent. oxygen is sufficient. Nitrogen escapes from each iron cylinder by a side tube which dips under water. The silk bags used for dialysing air are prepared by washing ordinary caoutchouc with a mixture of carbon disulphide and alcohol (whereby substances are removed which would readily stop the pores of the caoutchouc-covered silk) making into a paste with benzene, and placing a layer of this between two layers of silk.

IN the *Scientific Proceedings* of the Ohio Mechanics' Institute (i. 35) a process is described for melting iridium by heating in a Hessian crucible with phosphorus, and subsequent renewal of the phosphorus by repeated fusion with lime. The metal, in very thin sheets, can be cut by a copper wheel making 2000 revolutions per minute, and having its surface covered with emery, or corundum, and oil. Metallic iridium is nearly as hard as ruby; no steel tools make any impression on it; attempts have been made, with fair success, to use it in place of carbon as the negative pole in the electric arc light.

IT is stated in the *Chemical Review* that recent analyses of the water from the *Holy Well* at Mecca, which is so eagerly drunk by pilgrims, show this water to be sewage, about ten times stronger than average London sewage.

ARTIFICIAL ivory of a pure white colour, and very durable has recently been manufactured by the inventor of celluloid: it is prepared by dissolving shellac in ammonia, mixing the solution with oxide of zinc, driving off ammonia by heating, powdering, and strongly compressing in moulds.

ON THE ALTERATIONS IN THE DIMENSIONS OF THE MAGNETIC METALS BY THE ACT OF MAGNETISATION[1]

DR. JOULE long since discovered that when a bar of iron was magnetised by an electric current, an *elongation* of the bar took place. In subsequent experiments, published in 1847, Joule found that the elongation amounted to about 1-200,000th of the length of the bar for the maximum magnetisation, and that the total elongation was nearly proportional to the square of the actual magnetisation. By placing the bar in a vessel of water stopped with a capillary tube, it was found that the volume of the iron did not augment, and hence Joule concluded that the sectional area diminished in proportion to the elongation. Under longitudinal tension, magnetisation caused a *shortening* of the rod when the tension exceeded 600 lbs. for a rod a quarter of an inch square. Soft steel behaved like iron; but hard steel, under all circumstances, Joule found to shorten slightly when the magnetising current passed

In 1873 Prof. Mayer repeated Joule's experiments with new and delicate apparatus; the elongation of the iron he found to amount to 1-277,000th of its length for the maximum magnetisation. Mayer also found that soft as well as hard steel contracted under magnetisation.

[1] Paper read at the Southampton Meeting of the British Association by Prof. W. F. Barrett, F.R.S.E., Professor of Physics in the Royal College of Science, Dublin.

In the same year I made a series of experiments on the other magnetic metal, nickel and cobalt, and found that whilst cobalt lengthened under magnetisation, nickel appeared to suffer no change.[1] This result is surprising, for nickel more nearly resembles iron and cobalt than steel in magnetic properties, the former having little coercive force, and the latter very considerable retentive power. With entirely new apparatus the experiments were repeated, and a distinct *shortening* of the nickel was now found, cobalt elongating but not so much as iron. This observation is, I believe, new, the fact was first noticed by me on September 9, 1873, but some uncertainty as to the reliability of the apparatus I then used led me to put the matter aside till July, 1876, when the experiments were repeated, and the fact that cobalt elongates and nickel retracts under magnetisation, was fully confirmed.

The multiplying apparatus that was found to yield most satisfactory results was a simple form of optical lever, a mirror vertically fixed over the fulcrum of a lever of the first order, and reflecting a scale at some distance into an observing telescope. The apparatus will be more fully described in the report that will be presented next year; a committee, with a small money grant, having been appointed at a previous meeting of the Association to investigate this and certain other molecular changes accompanying the magnetisation of iron, described by the author at the Bradford meeting of the Association.

The results so far obtained may be summed up as follows:—However often the current traverses the helix around the bar of *cobalt*, the elongation is practically the same after the first current, and amounts to about two-thirds of the elongation produced in an iron bar of the same dimensions. In my measurement the elongation of the iron amounted to about 1-260,000th of its length for the maximum magnetisation; the iron elongated 5 scale divisions, and the cobalt 3, or 1-425,000th of its length. With *nickel*, the retraction on the same scale was 10, or twice the elongation of the iron, or about 1-130,000th of the length of the bar. Reversing the current made no alteration in the results. The index returned promptly to zero on the cessation of the current. The retraction of the nickel was so instantaneous that it was only by noting the scale-reading that any motion could be discovered to have taken place. The helix in all cases was the whole length of the bars.

Inclosing the bars in a vessel of water terminating in a capillary tube (the stem of a mercurial thermometer of extremely fine bore), and surrounding the vessel by a powerful magnetising helix, no motion of the water-level in the capillary tube was noticed with iron and cobalt on the making, breaking, or reversing the current in the helix; with nickel no motion was observed on making, and a barely perceptible, but still definite, fall of the index, equal to about 1-10,000,000th of the volume of the bar, occurred on breaking, which was more clearly seen by frequent interruptions of the current.

The "magnetic tick" is heard loudly with cobalt and nickel, as well as iron, the former giving a very clear metallic click on magnetisation.

I am much indebted to the kindness of Messrs. Johnson and Matthey for the bars of nickel and cobalt (9½ inches long and 1 inch diameter) with which the experiments were conducted, and also to Mr. Gore, F.R.S., for the loan of a longer bar of nickel. Experiments are now in progress to determine the effect of temperatures and longitudinal tensions on the result.

Preliminary experiments show, that raising the temperature of the iron and cobalt bars some 50° C. makes a scarcely appreciable difference in the amount they elongate, whereas, when nickel is heated the same amount, its retraction on magnetisation is, as might be expected, considerably diminished, being about three-fourths of the amount occurring at the temperature of the air. Owing to the short length of the bars, the actual elongation measured was, in the case of the cobalt, only the 1-46,000th of an inch, but a difference of 100,000th of an inch could confidently be measured.

SUNLIGHT AND SKYLIGHT AT HIGH ALTITUDES

At the Southampton meeting of the British Association, Captain Abney read a paper in which he called attention to the fact that photographs taken at high altitudes show skies that are nearly black by comparison with bright objects projected against them, and he went on to show that the higher above the sea-level the observer went, the darker the sky really is and the fainter the spectrum. In fact, the latter shows but little more than a band in the violet and ultra-violet at a height of 8500 feet, whilst at sea-level it shows nearly the whole photographic spectrum. The only reason of this must be particles of some reflecting matter from which sunlight is reflected. The author refers this to watery stuff of which nine-tenths is left behind at the altitude at which he worked. He then showed that the brightness of the ultra-violet of direct sunlight increased enormously the higher the observer went, but only to a certain point, for the spectrum suddenly terminated about 2940 wave-length. This abrupt absorption was due to extra atmospheric causes and perhaps to space. The increase in brightness of the ultra-violet was such that the usually invisible rays L, M, N could be distinctly seen showing that the visibility of these rays depended on the intensity of the radiation. The red and ultra-red part of the spectrum was also considered. He showed that the absorption lines were present in undiminished force and number at this high altitude, thus placing their origin to extra atmospheric causes. The absorption from atmospheric causes of radiant energy in these parts he showed was due to "water-stuff," which he hesitated to call aqueous vapour, since the banded spectrum of water was present, and not lines. The B and A line he also stated could not be claimed as telluric lines, much less as due to aqueous vapour, but must originate between the sun and our atmosphere. The author finally confirmed the presence of benzene and ethyl in the same region. He had found their presence indicated in the spectrum at sea-level, and found their absorption lines with undiminished intensity at 8500 feet. Thus without much doubt hydrocarbons must exist between our atmosphere and the sun, and it may be in space.

PROF. LANGLEY, following Capt. Abney, observed: The very remarkable paper just read by Captain Abney has already brought information, upon some points which the one I am about, by the courtesy of the Association, to present, leaves in doubt. It will be understood then that the references here are to his published memoirs only, and not to what we have just heard.

The solar spectrum is so commonly supposed to have been mapped with completeness, that the statement that much more than one half its extent is not only unmapped but nearly unknown, may excite surprise. This statement is, however, I think, quite within the truth, as to that almost unexplored region discovered by the elder Herschel, which lying below the red and invisible to the eye, is so compressed by the prism, that though its aggregate heat effects have been studied through the thermopile, it is only by the recent researches of Capt. Abney that we have any certain knowledge of the lines of absorption there, even in part. Though the last named investigator has extended our knowledge of it to a point much beyond the lowest visible ray, there yet remains a still remoter region, more extensive than the whole visible spectrum, the study of which has been entered on at Alleghany, by means of the linear Bolometer.

The whole spectrum, visible and invisible, is powerfully affected by the selective absorption of our atmosphere, and that of the sun; and we must first observe that could we get outside our earth's atmospheric shell, we should see a second and very different spectrum, and could we afterward remove the solar atmosphere also, we should have yet a third, different from either. The charts exhibited show:—

1st. The distribution of the solar energy as we receive it, at the earth's surface, throughout the entire invisible as well as visible portion, both on the prismatic and normal scales. This is what I have principally to speak of now, but this whole first research is but incidental to others upon the spectra before any absorption, which though incomplete, I wish to briefly allude to later. The other curves then indicate.

2nd. The distribution of energy before absorption by our own atmosphere.

3rd. This distribution at the photosophere of the sun.

The extent of the field, newly studied, is shown by this drawing (chart exhibited). Between H in the extreme violet, and A in the furthest red, lies the visible spectrum, with which we are familiar, its length being about 4,000 of Ångstrom's units. If, then, 4,000 represent the length of the visible spectrum, the chart shows that the region below extends through 24,000 more, and so much of this as lies below wavelength, 12,000, I think, is now mapped for the first time.

We have to $\lambda = 12{,}000$, relatively complete photographs, pub-

[1] *Phil. Mag.*, January, 1874.